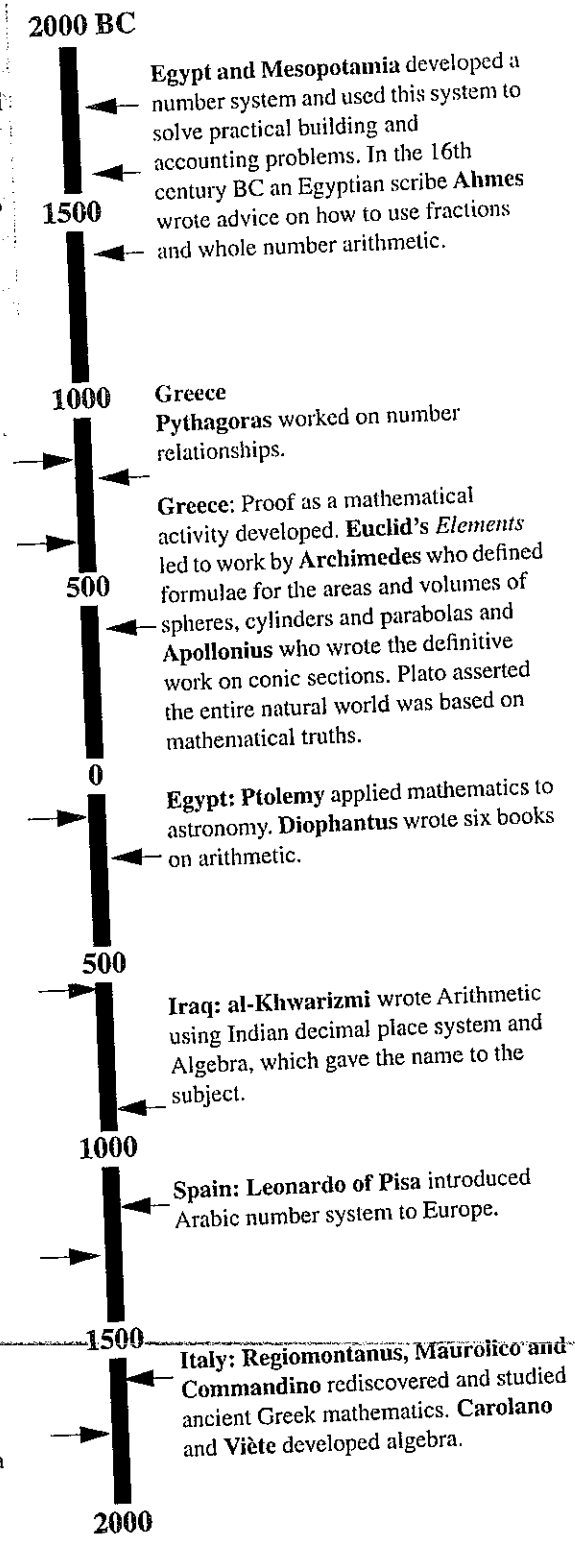
A (very) Brief History of Mathematics

This time line shows some of the key features of the development of mathematical thinking up to the end of the eighteenth century. In the 19th and 20th centuries mathematics, both pure and applied, has developed enormously throughout the entire world. The development of computers, which grew out of a demand to speedily handle and process numbers, has itself brought about a revolution in mathematical creativity.



3.1.4 A PRIORI KNOWLEDGE: THE SOURCE OF AXIOMS?

Mathematics then is a formal system of knowledge based on axioms to which are deductively applied rules of inference to create theorems. The process, the application of the rules to create theorems, is easily understood. What is not so easily understood is the genesis, the origins, of the axioms. Arithmetical theorems follow deductively from Peano's Postulates. Pythagoras's famous theorem follows deductively from Euclid's Elements, but the evidence for the axioms themselves seems to be rather vague.

A MAGNIFICENT SEVEN

Seven modern mathematicians who have influenced the progress of mathematical thinking in the last two hundred years are described below. In common with all successful mathematicians their best work was done when they were young. It is safe to say that if you haven't distinguished yourself as a mathematician by the time you are thirty, you probably never will.

Bernhard Riemann (1777-1885). Born in Breselenz, Germany, he became professor of mathematics at Göttingen in 1859. As a young man Riemann worked with the theory of functions but he is famous for his later development of non-Euclidean geometry. His theories in non-Euclidean geometry were significant for the subsequent development of the Theory of Relativity. The Riemann Hypothesis (1857) concerning the distribution of prime numbers is still awaiting proof.

Nikolay Lobachevsky (1792-1856). Born in Nizhny Novgorod, Russia, he became professor at Kazan in 1816. He too developed a theory of non-Euclidean geometry in which Euclid's parallel postulate did not hold.

Henri Poincaré (1854-1912). Born in Nancy, France, he became professor of mathematics in Paris in 1881. He was the first mathematician to predict Chaos Theory and he also defined the foundations of topology and triangulation. Some of his late work, like Riemann's, anticipated Einstein's Theory of Relativity.

David Hilbert (1862-1943). Born in Königsberg, Germany, he became a professor there in 1893. His early work included a critical examination of the foundations of geometry as well as making important contributions to number and invariant theories and algebraic geometry. At the International Congress of Mathematicians in 1900 he listed 23 problems which he regarded as important for contemporary mathematicians, some of which are still unsolved.

John von Neumann (1903-1957). Born in Budapest, Hungary, he emigrated to America in 1933 and joined the Institute for Advanced Study at Princeton. He wrote a major work in quantum mechanics and defined a new set of axioms for set theory. During the Second World War he provided a mathematical description of shock waves caused by bombing. His work on high speed calculations contributed to the development of the computer. He defined Game Theory, a mathematical concept much used by economists.

Bertrand Russell (1872-1970). Born in Trelleck, Wales, he studied at Cambridge and became a fellow of Trinity College there in 1895. Convinced of the objectivity of mathematics Russell published Principles of Mathematics (1903) and, with A N Whitehead, *Principia Mathematica* (1910-1913). Russell's claim to the complete objectivity of mathematics was based on two principles: 1.Mathematical truth is pure logic and 2. because of this Mathematics has no subject matter.

Kurt Gödel (1906-78). Born in Brno in the Czech Republic, he emigrated to America in 1940 and joined von Neumann at the Institute for Advanced Study in Princeton. He is famous above all for his proof, known as Gödel's Proof, that any formal logical system adequate for number theory must contain propositions not provable in that system, a problem at the very heart of mathematics. Gödel's proof persuaded Russell that his conviction of the logical truth of mathematics was questionable.